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ABSTRACT

This study investigated factors associated with top and bottom achievement groups for students enrolled in the Intermediate Science Curriculum Study (ISCS) program. Differences between achievement groups within Levels I, II and III of ISCS were also investigated. A cross-sectional sample of Level I (n=372), Level II (n=290) and Level III (n=379) served as the data source. Students were enrolled in one of two junior high schools within the suburban Philadelphia school district. Achievement was treated as a dependent variable. Achievement groups were contrasted on a series of eleven factors with their counterparts within and between levels using discriminate analysis. Significant differences were found between achievement groups at all levels. Working style and emotional attitude toward science were sharp points of contrast between high and low achievers. Comparison of low achievement groups between Levels I and II, and II and III indicated that reading was the only factor which differed significantly. Similar comparison with high achievers indicated an increased need for computational skills and mathematical apptitude in proceeding from Level I to II. (Author/HM)

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DIFFERENCES AMONG FACTORS ASSOCIATED WITH ACHIEVEMENT GROUPS WITHIN AND BETWEEN ISCS LEVELS I, II & III

by

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Differences Among Factors Associated with Achievement Groups Within and Between ISCS Levels I, II & III

Introduction:

The Intermediate Science Curriculum Study (ISCS) has not only become one of the most widely implemented NSF curricula, but also has catalyzed numerous research studies. "The expressed purpose of the Intermediate Science Curriculum Study (ISCS) project from its beginning was the structuring of individualized, self-paced activity-centered, sequential set of materials for the intermediate grades" (Darrow, 1972, p. 38). In this curriculum which is described in detail elsewhere (Burkham, 1970; 1974), Levels I, II and III generally correspond to grades 7, 8 and 9. Emphasis in the first two levels is upon energy and matter respectively in a conceptual sense while scientific processes from measurement to model building are developed. Level III modules include topics from physical and biological sciences.

The research reported herein examines attribute-treatment interactions at all levels of ISCS. Understanding the interrelationships between instructional approach and student attributes is a prerequisite to prescriptive instruction (Tobias, 1976; Webster and Mendro, 1974). When viewed in this light, the present research is subsumed by a more extensive inquiry. One which aspires to develop a practical approach to predicting students' achievement. Of principle interest to the present investigations are factors associated with top and bottom achievement groups. Data on a set of factors including aptitude,

attitude, knowledge, and skills were analyzed using step-wise discriminant analyses. Previous research demonstrated significant differences between achievement groups in ISCS Level I (McDuffie and Beehler). Yet, a discriminant function based upon this data proved to be a disappointing predictor of performance on Level II (McDuffie, 1977). Examination of Levels II and III is a direct extension of the earlier effort. Analysis of the factors associated with high or low achievers between levels should provide an index of the stability of discriminating factors within ISCS. Two sets of questions were addressed:

1. Are there significant differences between achievement groups within Levels I, II and III?
2. Do the factors associated with achievement groups vary from level to level?

Background:

After an extensive literature review, (Walker and Schaffarzick, 1974) concluded that differences of the outcomes associated with NSF programs and traditional approaches were better reflectors of the measuring devices used than instructional strategies. ISCS provides few contradictions to this generalization. When compared to New York State Science Syllabus, no significant differences were detected on understanding science, critical thinking and student attitudes (Hefferman, 1973). A semester long, Florida study found insignificant correlations between instructional approach and achievement, self-concept, and attitude towards science (Martinez-Perez, 1973). Analysis of covariance failed to detect significant differences in inquiry skills developed by seventh graders in ISCS and non-ISCS studies (Stallings and Snyder,

1977). Minimum differences in achievement of facts and concepts, critical thinking, and subject preference were observed by James (1972), but the study did indicate superior understanding of the aims and methods of science were related to ISCS.

Studies contrasting ISCS subgroups have proven somewhat more fruitful, particularly as a guide to selecting variables associated with achievement level. Interrelationships between aptitude and achievement in Level I (McDuffie & Beehler) as was rate of progress (Gabel and Herron, 1977). Other areas of contrast includes self-directedness (McCurdy, 1975) and workstyle (McDuffie, 1977); although, prior knowledge of behavioral objectives might reduce such distinctions (Johnson and Sherman, 1975). Understanding of science is another highly discriminating factor. High achievers have significantly better understanding of the empirical and changeable nature of science than do their counterparts (Lashier and Nieft, 1975). A positive relationship between reading skills and success in ISCS has been broadly noted (ISCS Newsletter, 1970; Zorn, 1971; Allen, 1974).

Procedure:

A cross-sectional sample of Level I (n=372), Level II (n=290) and Level III (n=379) served as the data source. Students were enrolled in one of two junior high schools within the suburban Philadelphia school district. The system, which had implemented ISCS several years prior to this investigation, includes a middle to upper-middle class, college oriented population. Information was obtained on eleven variables as summarized in Table I. Excepting workstyle and achievement the means of measuring the studies factors are commonly found in school district

Table 1

Personal Factors and the Method of Measurement.

Factor	Mode of Measurement	Reliability (K-R 20)
Achievement	Standardized Test developed by Rose Tree-Media School District	0.82
Work-style	Teacher Rating	0.95
Attitude Toward Science	Scientific Attitude Inventory	0.93
Emotional		
Intellectual		
Aptitude	Scholastic Aptitude Test (SCAT)	
Verbal		0.92
Quantitative		0.90
Skills and Knowledge	Sequential Test of Educational Progress	
Science		0.82
Basic Concepts		0.80
Computation		0.87
Reading		0.88
Sex	Self-Analysis	

records, or are easily administered. SCAT and STEP tests are used nationwide and have well established content validity (Anastasi, 1976). Scientific attitude inventory, an instrument commonly referred to in the literature, was validated during its generation (Moore and Sutman, 1970). The development and validation of the forty-item, multiple choice achievement indices as well as the rating system for workstyle are outlined elsewhere (McDuffie and Beehler).

Statistical Analysis and Results:

Throughout the study, achievement was treated as a dependent variable. Achievement groups were contrasted with their counterparts within and between levels using discriminate analysis (Nie, et. al., 1975). The step-wise approach employed adds predictors in order of their ability to minimize Wilk's Lambda (Tatsuoka, 1971). Membership among the high achievers required a t-score of 57 or better. A score less than 44 led to inclusion among the low achievers.

Results, summarized in Table 2, show significant differences ($\alpha \leq .01$) between high and low achievers at each ISCS level. The role of workstyle and attitude toward science found at Level I confirms earlier results. Workstyle is the prime discriminator throughout the program. While students' ability to perform within the instructional format should have a relationship with achievement, teacher ratings might magnify the association. Student attitude toward science, particularly the affective dimension, is a delimiting factor at all levels. Quantitative ability plays a minor role at Level I, but has a greater bearing upon achievement later in the program. Reading's minimal role contradicts the general impression of the literature, but confirms the author's earlier findings. Apparently

Table 2

Factors Discriminating Between Achievement Groups*

Within Each Level

	VARIABLE	F TO ENTER	WILK'S LAMBDA
	Workstyle	86.9	.68
	Emotional Attitude Toward Science	4.3	.67
Level I	Intellectual Attitude Toward Science	1.9	.66
n = 372			
	% Correctly Classified	74.5	
	Workstyle	46.8	.76
	SCAT Quant	7.4	.72
	Basic Concepts	20.1	.64
Level II	Emotional Attitude Toward Science	1.6	.63
n = 290	Reading	1.2	.62
	Computation	1.1	.62
	% Correctly Classified	78.7	
	Workstyle	78.4	.71
	SCAT Quant	6.6	.69
Level III	Emotional Attitude Toward Science	1.8	.68
n = 379	Sex	2.7	.67
	% Correctly Classified	79.3	

*($\alpha \leq .01$)

the general reading level of the present population surpasses programatic requirements. The ability of the discriminant functions to classify individuals was tested by contrasting predictions with actual group membership on each level. As Table 2 indicates 75 to 80% of the high and low achievers were properly assigned.

The second aspect of the analysis involved contrasts of achievement groups between levels. Table 3 summarizes the findings for the low achievement groups. No factor discriminates significantly between low group at Levels I and II. Reading is a significant point of contrast from Level II to III.

When trends are examined throughout all three levels, results become more noteworthy. Aptitude and skills play more significant parts. Average scores in mathematical and verbal ability as well as in computational and other skills increase from the first through the third year. While a slight decrease was observable in emotional attitude toward science, the intellectual component actually increased during the program.

Comparisons of high achievement groups, Table 4, are both more complex and more statistically significant. When all three grades are considered, students with better mathematical and reading skills and aptitudes tend to be higher achievers. Greater differences were found between the top groups at Levels I and II than those at Levels II and III. Computational skills and mathematical ability are among the significant factors. Reading and workstyle demonstrate the greatest differences in proceeding from the second to the third year.

Table 3

Summary of Discriminating Factors

Between Low Achievers*

Levels Contrasted	Variables Entered	F To Enter	Wilk's Lambda
I-II	Intellectual Attitude Toward Science	3.5	.98**
II-III	Reading	43.3	.82
I-III	Basic Concepts	39.1	.80
	Computation	3.8	.78
	SCAT Quant	2.8	.76
	SCAT Verbal	2.3	.75
	Emotional Attitude Toward Science	1.5	.74
	Intellectual Attitude Toward Science	1.4	.74

* ($\alpha \leq .01$)

** not significant at $\alpha \leq 0.05$

Table 4

Summary of Significant Discriminating Factors
Between High Achievers

Levels Contrasted	Variables Entered	F To Enter	Wilk's Lambda
I-II	Computation	4.3	.97
	Basic Concepts	33.8	.80
	SCAT Quant	24.6	.69
	SCAT Total	14.9	.63
	Sex	1.5	.62
II-III	Reading	24.1	.85
	Workstyle	3.3	.83
	Intellectual Attitude Toward Science	1.1	.83
	Computation	1.0	.82
	Basic Concepts	2.7	.80
	SCAT Total	1.9	.79
I-III	Reading	14.7	.88
	Computation	6.1	.84
	Basic Concepts	27.3	.67
	SCAT Quant	13.0	.68
	Workstyle	2.9	.59
	SCAT Verbal	2.1	.57

* ($\alpha \leq .01$)

Summary and Conclusion:

Contrasts within and between achievement groups is presented in the body of the report. A populaton of approximately 1000 ISCS students were the data base. Statistical analysis contrasted score on eleven aptitude, attitude and skill factors within and between grade levels. Significant differences were found between achievement groups at all levels. Workstyle and emotional attitude toward science are sharp points of contrast between high and low achievers; this, reconfirming the truism that interested students perform better than uninterested ones. More importantly it suggests the need for planned, motivated activities at all levels of ISCS instruction.

Comparison of low achievement groups between Levels I and II, and II and III indicate that reading is the only factor which differs significantly. Similar comparison with high achievers indicate an increased need for computational skills and mathematical aptitude in proceeding from Level I to II. Reading, workstyle and intellectual attitude toward science demonstrate significant differences between the next two levels.

As students proceed through the program reading and mathematical skills become increasingly important. Less able, enthusiastic students are able to achieve at higher levels during the first year, but attitude is not sufficient to sustain this achievement level. As the conceptual demands of the material increases a paralleling change in student ability must occur. Throughout the three years of the program the average aptitude scores of the low achievers decreases while those of the high achievers increases.

From the vantage point of predicting achievement, the variability from grade to grade necessitates a rethinking of the procedure alluded

to. Possibly specific functions must be generated for each achievement group before differential effects can provide a viable basis for forecasting achievement level.

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